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Hays et al.

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[54] **PACKAGE HEAT EXCHANGER SYSTEM FOR HEATING AND COOLING**

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[73] Assignee: **Raytheon Company**, Lexington, Mass.

[21] Appl. No.: **699,418**

[22] Filed: **Jun. 24, 1976**

Related U.S. Application Data

[63] Continuation of Ser. No. 533,599, Dec. 17, 1974, abandoned, which is a continuation of Ser. No. 185,631, Oct. 1, 1971, abandoned.

[51] **Int. Cl.**[2] **F25B 19/00**

[52] **U.S. Cl.** .... **165/58**; 165/140; 236/20 R; 237/8 R; 237/16

[58] **Field of Search** .... 165/63, 59, 60, 64, 165/48, 181, 140, 58; 126/101; 237/16–18, 8 R, 7; 122/367; 236/20 R

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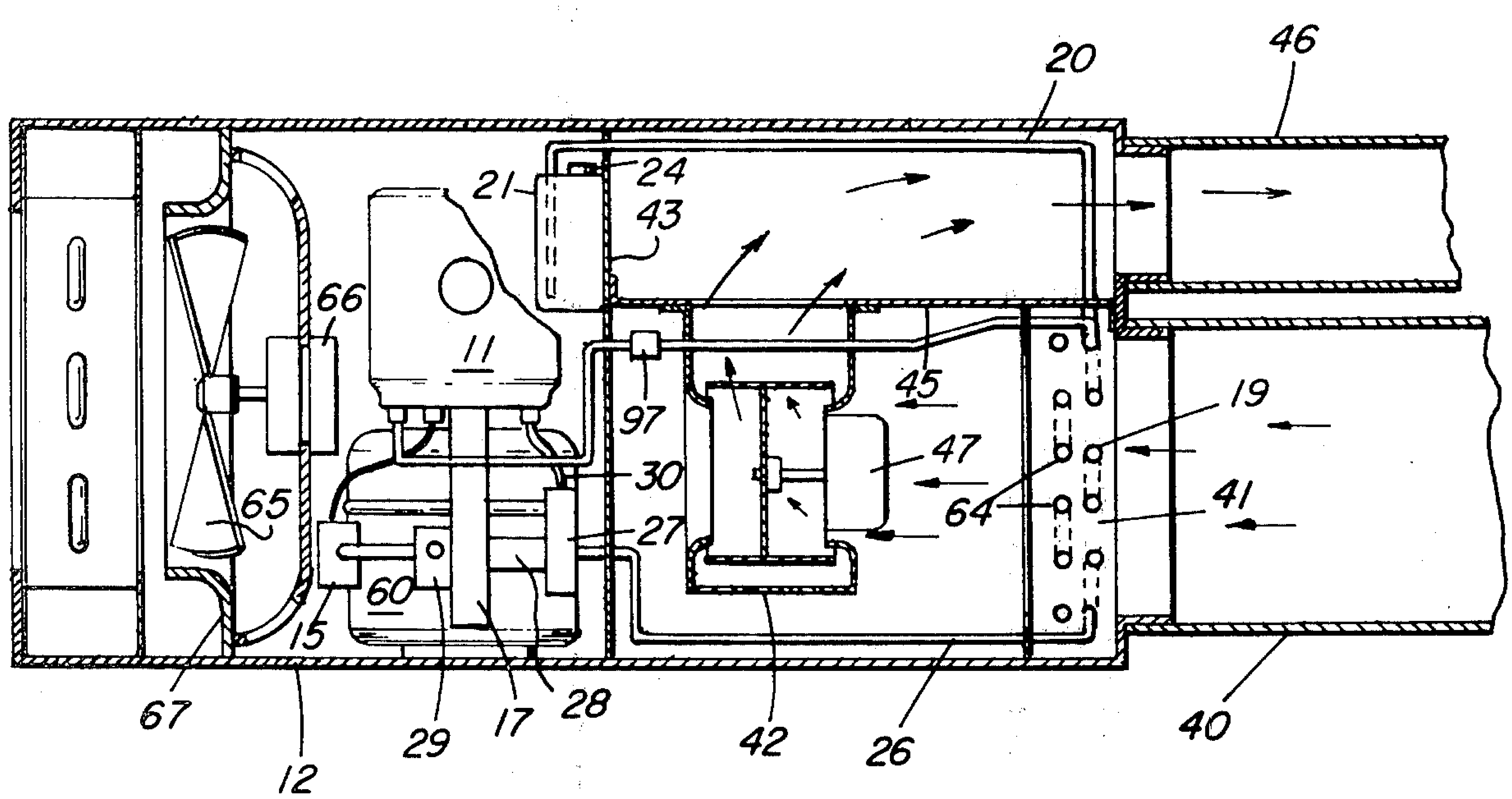
Primary Examiner—Albert W. Davis, Jr.
Attorney, Agent, or Firm—M. D. Bartlett; J. D. Pannone; H. W. Arnold

[57] **ABSTRACT**

A compact heating and cooling system in which air ducts are connected to a heat exchanger system through which a coolant fluid from a condensing unit or a heating fluid from a compact water heater is selectively directed by a control circuit so that the system may be mounted outside a building to be heated and/or cooled.

14 Claims, 6 Drawing Figures



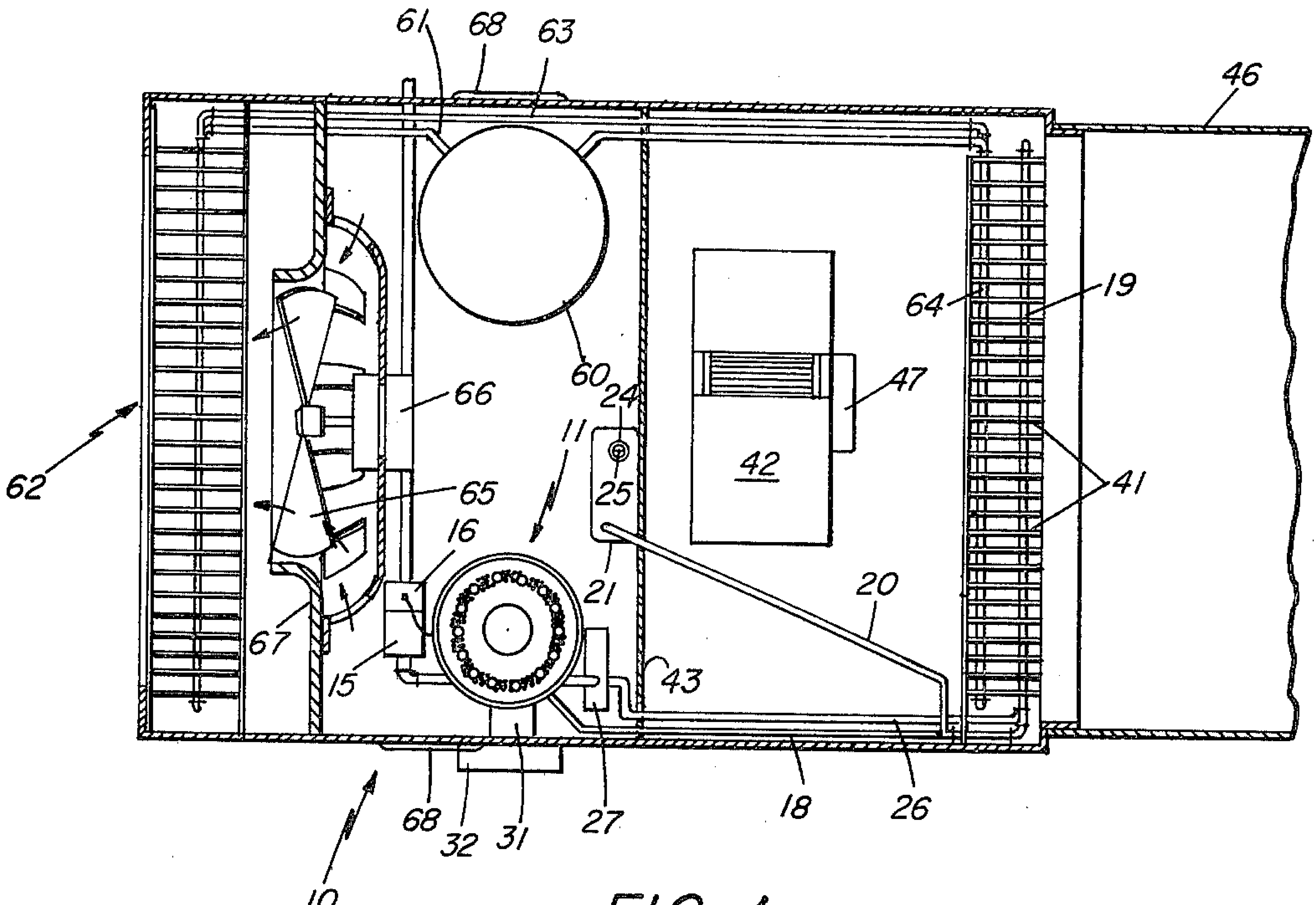

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FIG. 1

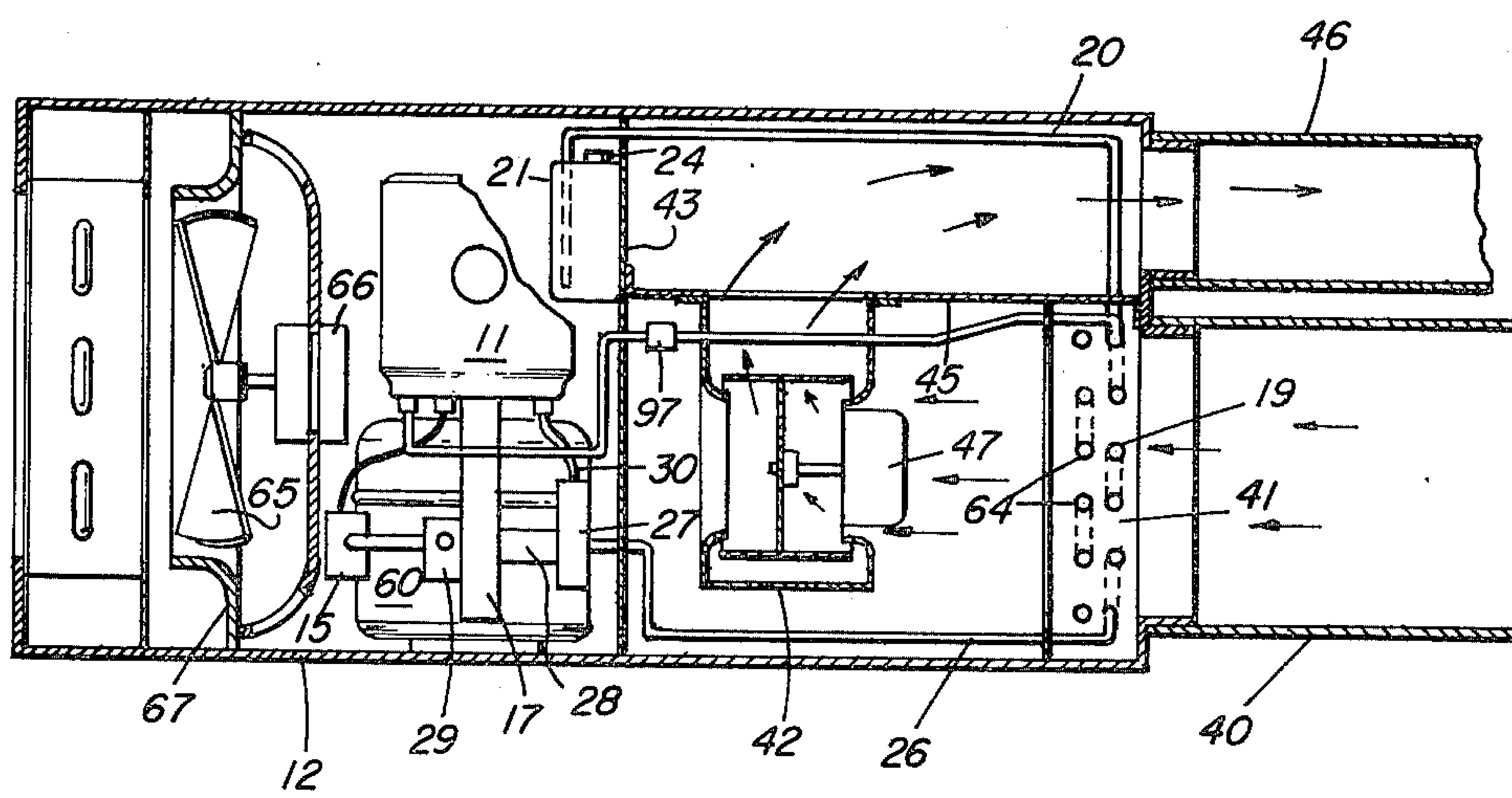
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FIG. 2

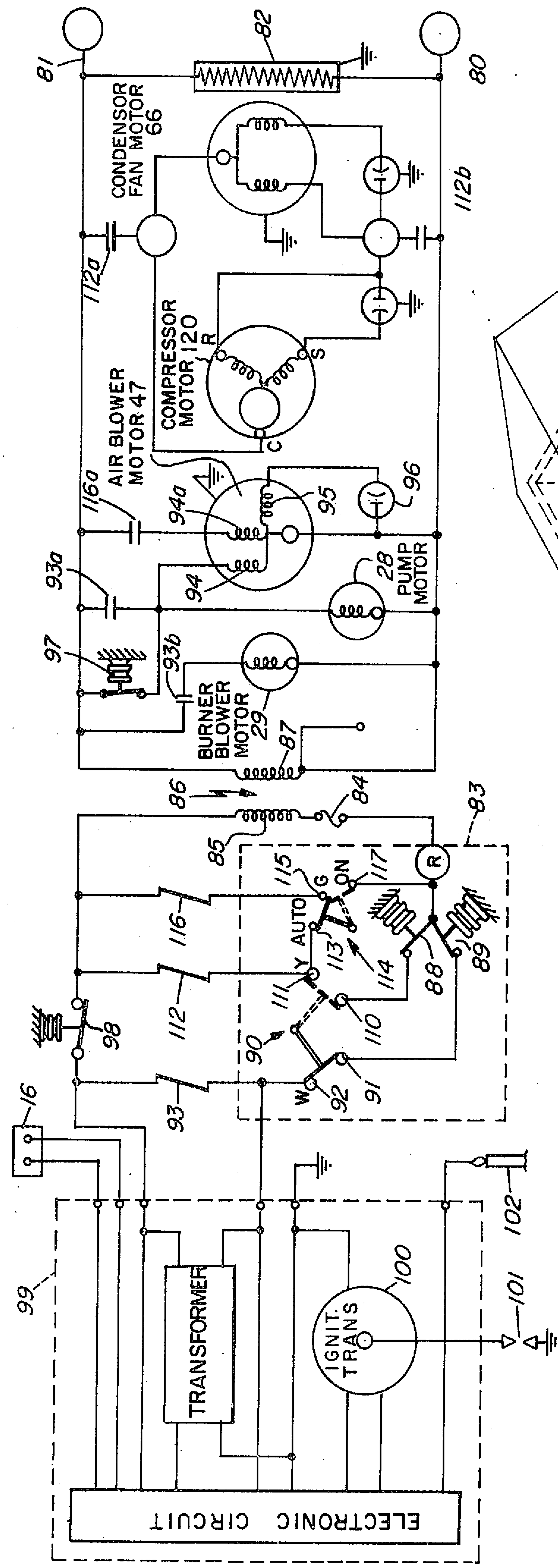

CONDENSOR FAN MOTOR 66
COMPRESSOR MOTOR 120
AIR BLOWER MOTOR 47
PUMP MOTOR
BURNER BLOWER MOTOR
TRANSFORMER
IGNIT. TRANS
ELECTRONIC CIRCUIT
AUTO
ON

FIG. 6

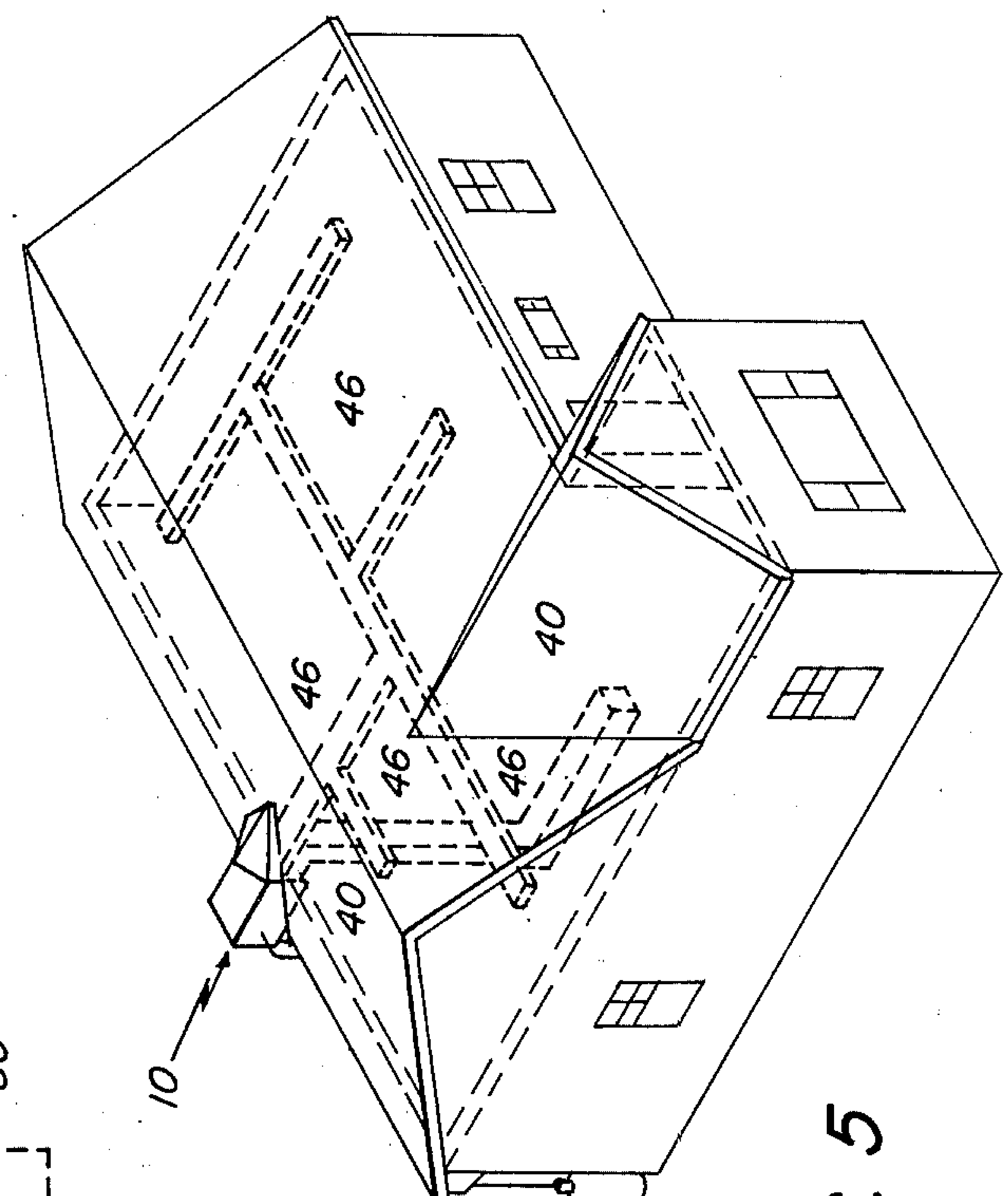
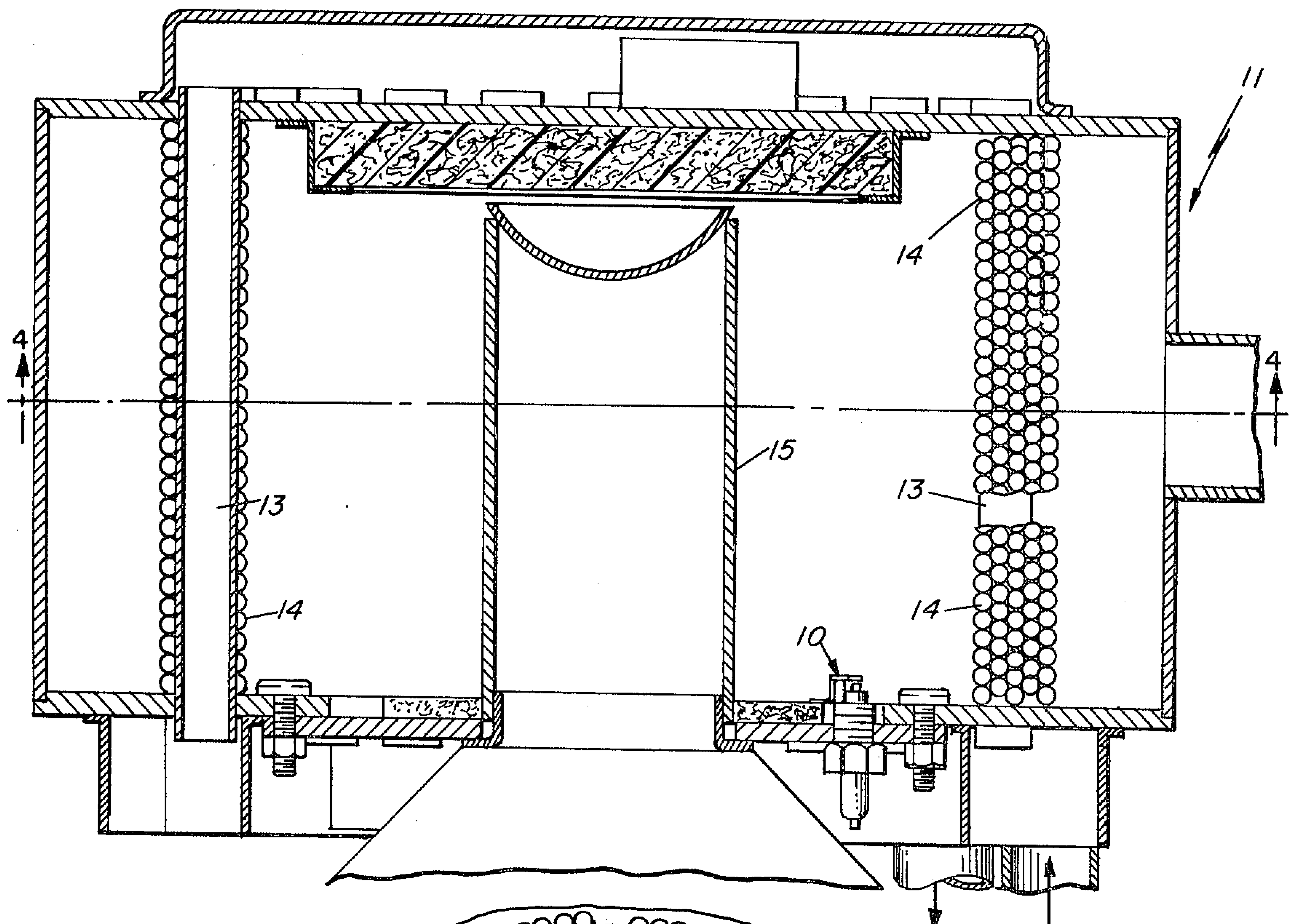


FIG. 5

FIG. 3



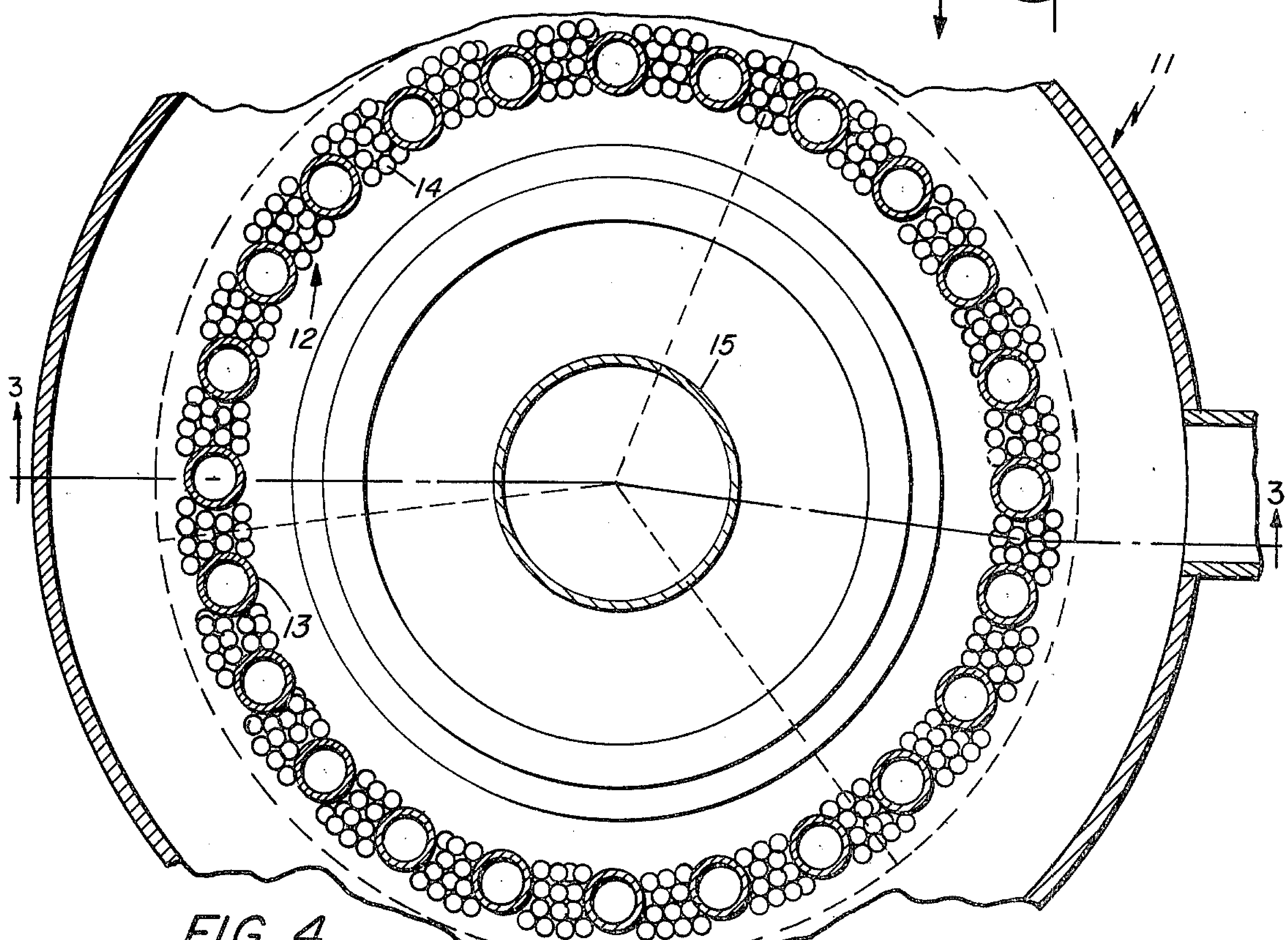


FIG. 4

PACKAGE HEAT EXCHANGER SYSTEM FOR HEATING AND COOLING

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation of application Ser. No. 533,599 filed Dec. 17, 1974, which is a continuation of application Ser. No. 185,631 filed Oct. 1, 1971 (now abandoned).

Application Ser. No. 10,334 (now U.S. Pat. No. 3,704,748) entitled Heat Transfer System filed Feb. 11, 1970, by William H. Hapgood and assigned to the parent company of the assignee of this invention is hereby incorporated herein and made a part of this disclosure.

BACKGROUND OF THE INVENTION

Combined heating and cooling systems are known in which a warm air furnace has associated therewith an air conditioning system having a cooling coil is placed in the air duct. However, such systems are essentially two complete systems, one a hot air heater which is relatively large and bulky and the other a complete air conditioner which is also relatively large and bulky.

It is also known that a common heat exchange liquid may be pumped throughout a large building to radiators having blowers associated therewith which will either blow hot or cold air depending on whether the liquid being circulated through the radiators has been heated or cooled by remotely located boilers or air conditioners.

Package heating and cooling units are also known where electric heating coils are placed in the cooling air ducts to heat the air when desired. However, such electric heat is neither economical nor sufficient for the total heating load in many areas of the country.

SUMMARY OF THE INVENTION

This invention discloses a compact combination heating and cooling system in which a heater comprises a compact matrix heat exchanger for heating a fluid with the products of combustion. The fluid, which is preferably a liquid such as water, is circulated through a first heat exchanger in an air duct positioned in close proximity to the heater and hence the energy required to circulate the fluid from the heater through the air duct heat exchanger is minimized. An air cooled condensing unit is positioned adjacent the heater with a separate expansion type cooling heat exchanger in the same air duct path as the heating radiator. A single blower drives air through both heat exchangers in the air duct so that when the air conditioner is energized cold air is circulated through the duct work and when the heater is energized hot air is circulated through the duct work. The entire system assembly is packaged with the heat rejection heat exchanger of the condensing unit positioned at one end of the package and the heat exchangers in the air duct positioned at the other end of the package so that the package may be conveniently placed outside a home with the air ducts extending through a roof or wall of the home and connecting with ducts for distribution of the heated or cooled air throughout the home. By the use of a matrix type heater, several times more heat may be added to the air in the ducts during heating than is extracted during cooling and hence the package can be used for the total heating or cooling required in a home in any climate in the country.

This invention further discloses that a liquid may be used for circulating fluid through the heater's matrix heat exchanger and the heat exchanger in the air duct, and that such liquid may be operated at substantially atmospheric pressure thereby permitting a reduction in weight and cost of the heat exchangers compared with heat exchangers which would be required if they operated above atmospheric pressure. This is accomplished by circulating the liquid and blowing the air through the air ducts whenever the temperature of the fluid in the matrix heat exchanger is above a minimum temperature so that when the heater shuts down circulation of the liquid will continue thereby preventing boiling in the matrix heat exchanger which would result in loss of liquid from the system. Rapid recycling of the system is also possible with such a circulatory control system without which a substantial period of time for recycling is required since the formation of steam which would occur in the matrix heat exchanger would not cool the boiler sufficiently once it had been shut down until the boiler itself had cooled, for example, by radiation within the package configuration.

By packaging the entire assembly with the condenser for the air conditioner at one end and the heat exchangers for exchanging heat with the air to be circulated through the home at the other end, the components such as the condenser, compressor and the compact boiler or hot water heater positioned between the two ends a compact and inexpensive structure is achieved which may be assembled in the factory as a unit with the associated wiring and control circuitry and the duct work easily attached to the wall of the home. The package may be, for example, mounted on the roof or mounted directly against the wall of the home.

By the use of a combustion type heater in a package system which may be positioned outside the building, the heater fuel such as gas or oil may be stored outside the building and fed to the heater thereby eliminating a potential source of fire or odor.

This invention further discloses a double protection feature in the control circuit. More specifically, an upper limit safety switch, which is mounted on the heating unit, controls both the burner-blower and the gas burner control circuit. A gas pressure regulator feeds gas to the input of the burner-blower at a pressure slightly below atmospheric pressure such that if the gas control valve controlled by the burner control fails to close when the burner circuit is shut down, for example, by sticking of the solenoid valve, the blower supplying the burner will also shut down thereby eliminating the suction vacuum at the output of the gas regulator and hence stopping the flow of gas through the regulator.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 illustrates a top plan view of a heating and cooling system embodying this invention;

FIG. 2 illustrates a side elevation view of the invention illustrated in FIG. 1;

FIG. 3 illustrates a longitudinal sectional view of the heater illustrated in FIGS. 1 and 2 taken along line 3—3 of FIG. 4;

FIG. 4 illustrates a transverse sectional view of the heater illustrated in FIG. 3 taken along line 4—4 of FIG. 3;

FIG. 5 illustrates an installation of the system of FIGS. 1 through 4 in a home; and

FIG. 6 illustrates a schematic diagram of a control circuit for use with the system illustrated in FIGS. 1 through 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 through 4, there is shown a package unit 10 having a base on which are supported side walls and a top which may be made of sheet metal removably attached to an angle iron frame as in conventional package heating units.

Positioned adjacent one side of the package 10 approximately midway between the ends thereof is a compact heater unit 11 preferably of the type disclosed in greater detail in the aforementioned application.

As illustrated in greater detail in FIGS. 3 and 4, heater 11 consists of a cylindrical matrix 12 comprising a plurality of tubes 13 through which is circulated a liquid to be heated and the spaces between the tubes are filled with a plurality of spheres 14 bonded together and to the tubes to form the unitary thermally stable matrix 12. Flue gas produced by the products of combustion from a burner 15 centrally located within the matrix is forced outwardly through the spaces between the spheres along heat exchange paths having an average length through the matrix preferably less than 20 times the average radius of curvature of the spheres 14. Under these conditions large quantities of heat may be transferred from the burner 15 to the matrix. The liquid flowing through the tubes 13 extracts heat from the matrix to maintain all regions of the matrix below temperatures which would damage the matrix, for example, by melting the bonds between the spheres. More specifically, if the bonds between the spheres are formed by brazing copper plated steel balls, all regions of the matrix should be maintained below 1000° F.

Fuel is supplied to the heater 11 through a solenoid controlled valve 16 and a pressure regulator 15 whose output is gas at a pressure slightly below atmospheric pressure. The output of regulator 15 is fed to the input of a blower 17 driven by a blower motor 28 so that blower 17 supplies a fuel-air mixture to the burner 15 of the heater 11.

Liquid heated by the heater 11 is circulated through a pipe 18 to a heat exchanger 19 at one end of the package 10 and thence through a return pipe 26 to a return pump 27 which forces the fluid back through the tubes in the heater 11. As illustrated herein, the fluid makes six passes through the heat exchanger matrix 12 by reason of the upper and lower ends of tubes 13 communicating with upper and lower plenums having baffles which feed the input from pump 27 to the lower ends of a first group of four of the tubes 13, and the upper ends of said first group to the upper ends of a second group of said tubes 13 whose lower ends feed a third group and so on through six groups of tubes 13, with the last group feeding the heat exchanger 19 through pipe 18.

The upper end of heat exchanger coil 19 is also connected via pipe 20 to an expansion tank 21 having a vent pipe which is closed by a rubber grommet 24 having a slit 25 therein, hereinafter referred to as a split web grommet, to maintain the system substantially at atmospheric pressure while preventing any substantial vaporization of the liquid. The liquid may be, for example, pure water, or in the event the unit is to be mounted outside the area to be heated, a mixture of water and antifreeze such as ethyleneglycol.

Tank 21 is positioned in a region of the package without substantial heat insulation so that any vapors of the liquid which are generated in the system will condense in the tank 21.

A blower 42 driven by a blower motor 47 is positioned in the lower portion of a space between the heater 11 and the heat exchanger 19 which is separated from the region containing the heater 11 by a transverse wall 43. Blower 42 exhausts air through a horizontal wall 45 and thus draws air through fins 41 connected to heat exchanger coil 19 from a cold air return duct 40 which is connected to the system 10 adjacent heat exchanger 19. A duct 46 is connected to the outlet at the end of the package 10 above the duct 40 and conducts air which has been drawn over heat exchanger 19 back into the home to heat the home. The walls of the compartment containing the blower 42 may be insulated with insulating material (not shown) to prevent heat transfer of the air to the outside region of the system 10 and to absorb noise from the blower 42. As illustrated herein wall 43 separates the region containing the expansion tank 21 from the region into which blower 42 exhausts so that tank 21 may be maintained cooler than the output region from the blower 42 hence aiding in condensing any vapors produced in the heater system and entering the tank 21 through the pipe 20.

To provide for cooling the air blown into duct 46 by blower 42, for air conditioning, a cooling compressor 60 is provided on the opposite side of the cabinet from the heater 11. The compressor is of a conventional air conditioning type which compresses a refrigerant working fluid such as freon and supplies it through a pipe 61 to a condenser 62 of conventional type consisting of tubes and fins. Condenser 62 is positioned on the opposite end of the system 10 from the heating coil 19 and thus is exposed to the open air. A pipe 63 supplies cooled freon from condenser coil 62 to a freon expansion coil 64 which is attached to the same fin structure 41 as the coil 19 so that air passing from the intake duct 40 by the fins 41 will be cooled by the coil 64 when the compressor 60 is operating. The freon from coil 64 is then returned to compressor 60 by a return pipe. Additional components such as expansion valves and freon filter-driers may also be incorporated in the system in accordance with well-known practice.

By using the same set of fins 41 for both the heating coil 19 and the cooling coil 64, the resistance to air flow and hence the blower power required by the motor 47 driving the blower 42 is minimized since essentially the same fin area is required whether the air is being cooled or heated. If desired, of course, separate heat exchanger units with separate fins may be used in place of the coils 64 and 19 with the common fins 41. In addition, if desired, one of the coils such as, for example, the heating coil 19 may be placed in the upper compartment after the air has been blown up by the blower 42.

The condenser coil 62 has air blown over it from inside the unit 10 by means of a fan 65 driven by a motor 66. As illustrated herein, the fan 65 is mounted in a surrounding shroud 67 to improve fan efficiency.

Vents 68 on the sides of the package 10 in the region occupied by the heater 11 and the compressor 60 provide an air intake for burner blower 17 and/or air for fan 65 which also maintains compressor 60 in a condition where operation will not overheat it.

Referring now to FIG. 5, there is shown a typical installation of a package unit 10 in a home having a gabled roof. The package 10 mounted on the side thereof facing the back of the house and the ducts **40** and **46** are connected through the roof of the house into the attic. As illustrated herein, the duct **46** supplies air to the various rooms of the house through a distribution duct work system blowing the air which has been heated or cooled through the ceiling at the center of each room. The return air is collected by a central duct feeding the duct **40**. Gas for the heater **11** may come from a utility supply or from a storage tank at the back of the house from which a pipe is fed to the system **10** on the roof. The package unit **10** may alternatively be connected through the wall at the back of the house, may be set in a recess in the wall, may be placed in the basement or in a pit or on a slab at the side or back of the house. In the case of commercial installations or on other structures having flat roofs, the unit **10** may be placed on the roof.

Referring now to FIG. **6**, there is shown a control circuit for the package unit **10**. Power is supplied to lines **80** and **81** from a power supply system. As illustrated herein, the voltage on lines **80** and **81** may be, for example, a conventional 240 volt 60 cycle AC supply which in the case of conventional home power systems will have a voltage at 120 volts with respect to ground applied to each of the wires **80** and **81**. A crankcase heater for compressor **60** is connected directly across lines **80** and **81** so that whenever power is available to the package unit, sufficient heat is supplied to the compressor crankcase to maintain the oil in the crankcase substantially free of condensed refrigerant. By this means, the compressor will be maintained in a lubricated condition during operation whereas if refrigerant had been allowed to dissolve in the oil, upon starting of the compressor, the oil would foam thereby decreasing its lubricating ability.

The temperature in the area being heated or cooled is controlled by means of a thermostat **83** positioned in an area such as a room of the home. Thermostat **83** comprises two temperature control switches which, in accordance with well-known practice, are adjustable to various temperatures dependent on the mechanical setting of a bellows or bimetallic strip linkage. As illustrated herein, the thermostat switch **88** controls the cooling system and the thermostat switch **89** controls the heating system. The thermostat **83** is in a low voltage circuit supplied from lines **80** and **81** by means of a transformer **86** whose primary winding **87** is connected across lines **80** and **81** and whose secondary winding **85** supplies a lower voltage of, for example, 24 volts to the thermostat control circuit. More specifically one end of winding **85** is connected through a fuse **84** to a common terminal of thermostat switches **88** and **89**. The other end of winding **85** is connected through a thermostatically controlled limit switch **98** to a burner control unit **99** and to one end of a heater control relay coil **92**. The other terminal of thermostat switch **89** is connected to a terminal **91** of a manually operated heat-cool selection switch **90** which when set in the "heat" position connects terminal **91** to terminal **92** which in turn is connected to the other end of the relay coil **93**. Terminal **92** also feeds the other power input of the burner control unit **99**.

Thermostat switch **89** is operated by a mechanical temperature sensing device of any desired type such as a bimetallic strip or as illustrated herein by a bellows and is designed to open when the temperature reaches the desired level in the room to be heated. When the temperature drops below the desired level switch **89** closes energizing relay control winding **93** which closes relay contacts **93***a* thereby connecting a pump motor **28** which drives pump **27** across the lines **80** and **81**. Blower motor **47** driving blower **42** is also energized by contacts **93***a* which connect high speed winding **94** of motor **47** and its starting winding **95** fed by a condenser **96** across lines **80** and **81**.

Contacts **93***a* are in parallel with a water temperature control switch **97** which is placed on the line **18** to sense the temperature of the water as it comes out of the heater **11**. The temperature at which switch **97** closes is made, for example, 100° F. so that when the thermostat switch **89** has energized the system to produce heat from the heater **11** and the water, which is circulating since contacts **93***a* are closed, has risen above 100° F. switch **97** will close and thereafter when the burner for the heater **11** shuts down, the pump motor **28** and blower motor **47** will continue to run until the temperature of the water emerging from the heater falls below 100° F. Thus all the heat above 100° F. which has been stored in the heater **11** due to the metal heat sink effect is transferred to the air being circulated through the ducts **40** and **46**. In addition, since some portions thereof are substantially hotter than the liquid, the heat in the heater **11** must be removed or it will vaporize some of the liquid in the tubes **13** thereby driving portions of the fluid out the vent **25** and in addition opening limit switch **98** in the heater **11** which is set at a temperature of, for example, 200° F. Limit switch **98** would not reclose until the heat in the heater **11** had been dissipated by radiation, thereby increasing the recycle time of the heater.

The burner control module **99** may be of any desired conventional type and as illustrated herein comprises an ignition transformer **100** feeding an igniter plug **101** in heater **11**. The solenoid of gas valve **16** is also fed by a control circuit of the burner control system **99** such that when thermostat switch **89** closes, gas valve **16** opens supplying gas to the regulator **15**. When blower **17** starts it draws a relatively small flow of gas through the regulator **15** and as it comes up to speed and blows the full amount of air called for by the burner more gas passes through the regulator **15** and mixes with the air being blown into the burner by the blower **17**. Thus the gas-air mixture remains relatively constant independent of the speed of the blower, the burner does not start with an overrich supply of air-fuel matrix so that there is substantially no carbonization of the heater matrix **12** and no smoke appears at the output vent **32**.

Since the opening of limit switch **98** shuts down both the control module **99** and the relay **93** controlling the blower motor **28**, there is a double or redundant fail-safe action. If, for example, the gas valve **16** were to remain open when the control system **99** de-energized the solenoid of the valve **16**, for example, due to sticking of the valve, the burner blower motor **28** would be also de-energized by opening relay contacts **93***b* and therefore no gas would flow into the heater. Thus, there is both an electrical and a mechanical fail-safe system associated with the burner system.

When it is desired to operate the package unit as a cooling system, the manually operated selector switch **90** is placed in the cool position and under these conditions a contact **110** which is connected to the other terminal of cooling thermostat switch **88** from that connected to fuse **84** is connected to a contact **111** of switch **90** which is connected through a compressor control relay coil **112** to the junction between limit switch **98** and transformer secondary winding **85**. This energizes relay coil **112** which closes contacts **112***a* and **112***b* and energizes compressor motor **120** from buses **80** and **81**. As illustrated herein, the compressor motor is a conventional capacitor start and run single phase motor having a conventional overload switch associated therewith. Connected in parallel with compressor motor **120** is motor **66** which drives fan **65** to blow air over the condenser coil **62** so that whenever the compressor **60** is running the fan **65** is drawing air over the compressor **60** to ensure that it does not overheat and blowing the air over the condensor coil **62** to cool the compressed refrigerant being pumped thereto.

Terminal **111** of switch **90** is also connected via a terminal **113** to a manually operated automatic-manual switch **114** for controlling the blower **42**. In the automatic position, a relay coil **116** is energized via switch **114** by connecting terminal **113** of switch **114** to terminal **115** of switch **114** thereby closing relay contacts **116***a* to energize a low speed winding **94***a* of motor **47**. Thus when the thermostat switch **88** closes when the temperature in the room rises above a pre-selected value the compressor will start and the fan and the blower **42** will run at a reduced speed to circulate cooled air through the ducts **40** and **46**. The blower **42** is run at a reduced speed during cooling since the amount of heat being transferred during cooling is usually less than that required for peak heating loads. For example, the unit illustrated herein transfers 30 to 40,000 BTU's per hour during cooling and 100,000 BTU's per hour or more during heating.

For continuous operation of the blower **42** without thermostatic control, switch **114** is switched to the manual position so that relay coil **116** is energized by connection of contact **115** of switch **114** to terminal **117** of switch **114** which is connected directly to fuse **84** thereby bypassing the thermostat switch **88**. In this mode of operation the air will continuously circulate through the area being heated or cooled even when no heating or cooling is being supplied to the heat exchanger coils **19** or **64**.

This concludes the description of the preferred embodiment of the invention illustrated herein, however, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. For example, a compact unit as illustrated herein can use a compact heater circulating fluid to a heat exchanger positioned adjacent the unit which heats hot air for supply to a building to be heated without the installation of a condensing unit for cooling. In addition, heating fluid other than a liquid may be used such as steam or vapor of other fluids than water. Other means of supplying a cooling system could be used such as an adsorption heat pump system which could use the heat from the heater **11**. Also, systems may be used in which the circulating pump for the liquid is eliminated and the system can be designed to operate at any desired pressure by selection of the fluid to be circulated through the heater. Furthermore, many modifications of the control circuitry may be made to achieve the control functions set forth in this invention. Accordingly, it is intended that this invention not be limited to the particular details disclosed herein except as defined by the appended claims.

What is claimed is:

1. A package heat exchange system comprising:

two compartments joined together and separated by a partition;

first heat exchange means comprising first and second heat exchangers positioned in a first of said compartments adjacent a first wall region of said package spaced from said partition for exchanging heat with air passing through said first heat exchange means and an opening in said first wall region;

means positioned within said first compartment for blowing said air through said first heat exchange means and said first wall region opening;

second heat exchange means comprising a condenser for a first fluid comprising a heat pump working fluid positioned in said second compartment adjacent an opening in a second wall region spaced from said partition and said first wall region;

means positioned within said second compartment for blowing air through said condenser and said second wall region aperture to extract heat from said working fluid;

means positioned within said second compartment for compressing said working fluid and for circulating said working fluid between said second heat exchange means and said first heat exchanger of said first heat exchange means;

a heating unit positioned within said second compartment comprising third heat exchange means surrounding a chamber and means for supplying the products of combustion to said chamber for heating a second fluid;

said third heat exchange means comprising a combustion prod products heat exchanger having a surface area contacting said products of combustion which is substantially greater than the surface area of said heat exchanger contacting said second fluid;

means for circulating said second fluid directly between said second heat exchanger of said first heat exchange means and said combustion products heat exchanger for supplying heat to said air circulated through said first heat exchange means by said blower; and

means for maintaining said second fluid as a liquid substantially at atmospheric pressure and for preventing substantial vaporization of said liquid comprising circulating said liquid with said second fluid circulating means while blowing air with said blower through said first heat exchange means which maintains said liquid flowing through said combustion products heat exchanger at a temperature below the vaporization temperature of said liquid at atmospheric pressure.

2. The system in accordance with claim **1** wherein said third heat exchange means comprises a matrix of tubular elements bonded together with a plurality of bodies whose surfaces are predominantly curved in all directions and which provide passages for said products of combustion therethrough.

3. The system in accordance with claim **2** wherein said burner positioned within said combustion chamber burns an air-fuel mixture.

4. The system in accordance with claim **1** wherein a gas burner is positioned within said combustion chamber.

5. A heat transfer system comprising:

first and second regions of said system substantially isolated from each other;

first heat exchange means comprising first and second heat exchangers positioned in said first region;

second and third heat exchange means positioned in said second region;

said third heat exchange means comprising a combustion products heat exchanger having a plurality of tubular conduits surrouding a central plenum;

a fluid circulation system comprising first and second fluids and conduit means extending between said first and second regions;

means positioned in said second region for supplying thermal energy from the products of combustion through said central plenum and to said second fluid through said third heat exchange means; means in said first region for circulating air through said first heat exchange means

means for maintaining said second fluid as a liquid substantially at atmospheric pressure and for preventing substantial vaporization of said liquid comprising means for circulating said liquid with said circulation system at a rate which removes thermal energy from said combustion products heat exchanger while circulating air with said air circulating means through said first heat exchange means maintaining said liquid flowing through said conduits at a temperature below the vaporization temperature of said liquid at atmospheric pressure;

means for transferring thermal energy from said first heat exchange means to said second heat exchange means through said first fluid; and

means in said second region for circulating air through said second heat exchange means.

6. The heat transfer system in accordance with claim 5 wherein:

the surface area of said third heat exchange means in contact with said products of combustion is substantially greater than the surface area of said third heat exchange means on contact with said second fluid.

7. The heat transfer system in accordance with claim 6 wherein:

said third heat exchange means comprises a plurality of tubular elements rigidly interconnected by a plurality of members and defining a central plenum.

8. The heat transfer system in accordance with claim 7 wherein:

said means for providing the products of combustion comprises a burner positioned within said central plenum.

9. The heat transfer system in accordance with claim 8 wherein:

said fluid system comprises a first fluid compound and means for circulating said first fluid compound between said first and third heat exchange means and a second fluid compound and means in said second region for pumping thermal energy via said thermal pumping means between said first and second heat exchange means; and

said first and second fluid compounds being separated from each other by separate portions of said first heat exchange means and by separate conduits.

10. A package heating and cooling system comprising:

a package having first, second and third compartments;

said first and second compartments being separated from each other by said third compartment;

first heat exchange means in said first compartment, second heat exchange means in said second compartment and third heat exchange means in said third compartment;

said third heat exchange means comprising a plurality of tubular conduits surrounding a central plenum;

means connected between said first heat exchange means and said second heat exchange means for pumping thermal energy with a first fluid from said first heat exchange means to said second heat exchange means;

means for supplying thermal energy from the products of combustion to said third heat exchange means through said central plenum;

means permanently and directly connected between said first heat exchange means and said third heat exchange means for circulating a second fluid heated by said thermal energy from said products of combustion in said third heat exchange means through said first heat exchange means;

means for maintaining said second fluid substantially as a liquid at atmospheric pressure and for preventing substantial vaporization of said liquid comprising means for circulating said liquid with said second fluid circulating means at a rate which removes thermal energy from said combustion products heat exchanger at a rate maintaining said liquid flowing through said conduits at a temperature below the vaporization temperature of said liquid at atmospheric pressure;

means in said first compartment for blowing air through said first heat exchange means to heat said air when thermal energy from the products of combustion is being supplied to said third heat exchange means and to cool said air when thermal energy is being pumped from said first heat exchange means to said second heat exchange means; and

means for circulating air through said second and third compartments.

11. The package heating and cooling system in accordance with claim 10 wherein:

said means for circulating air through said second and third compartments comprises a fan positioned in an opening between said second compartment and said third compartment to blow air from said third compartment into said second compartment to cool said second heat exchange means when thermal energy is being pumped from said first heat exchange means to said second heat exchange means by said thermal energy pumping means.

12. The package heating and cooling system in accordance with claim 10 wherein:

said thermal pumping means comprises a compressor positioned in said third compartment.

13. The package heating and cooling system in accordance with claim 12 wherein:

said first heat exchange means comprises a plurality of sets of conduits, one of said conduit sets containing a first fluid which circulates through said thermal pumping means and another of said conduit sets containing a second fluid which circulates through said third heat exchange means.

14. The package heating and cooling system in accordance with claim 10 wherein:

said third heat exchange means comprises a heat exchanger having a heat exchange surface area exposed to said products of combustion which is substantially greater than the heat exchange area exposed to said fluid to be heated.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 4,125,151 Dated November 14, 1978

Inventor(s) Herbert G. Hays et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 55, "92" should read -- 93 --.

Column 6, line 35, after "igniter" insert -- spark --.

Column 6, line 47, "matrix" should read -- mixture --.

Signed and Sealed this

Seventeenth **Day of** *April 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks